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TECHNICAL REPORT No. 454-45.

GERMAN FLANGE GESCHOSS

SEPTEMBER 1945

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To : Chief of Naval Operations (OP-16-PT).

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TECHNICAL REPORT No. 454-45.

GERMAN FLANGE GESCHOSS

SUMMARY

The development and construction of the German sub-caliber projectiles designed to be fired from guns with a tapered, smooth bored muzzle extension.

September 1945

U. S. NAVAL TECHNICAL MISSION IN EUROPE

TABLE OF CONTENTS

GERMAN FLANGE GESCHOSS

German projectiles to be fired from guns of the "Littlejohn" of "Squeeze-Bore" type.

1. Introduction.

From the start of the war in 1939, German research personnel worked on the projects of developing high velocity guns and projectiles. In the high velocity projectile field sub-caliber projectiles were judged by the Germans to show the most possibilities of increasing range and decreasing the time of flight in comparison to standard type projectiles.

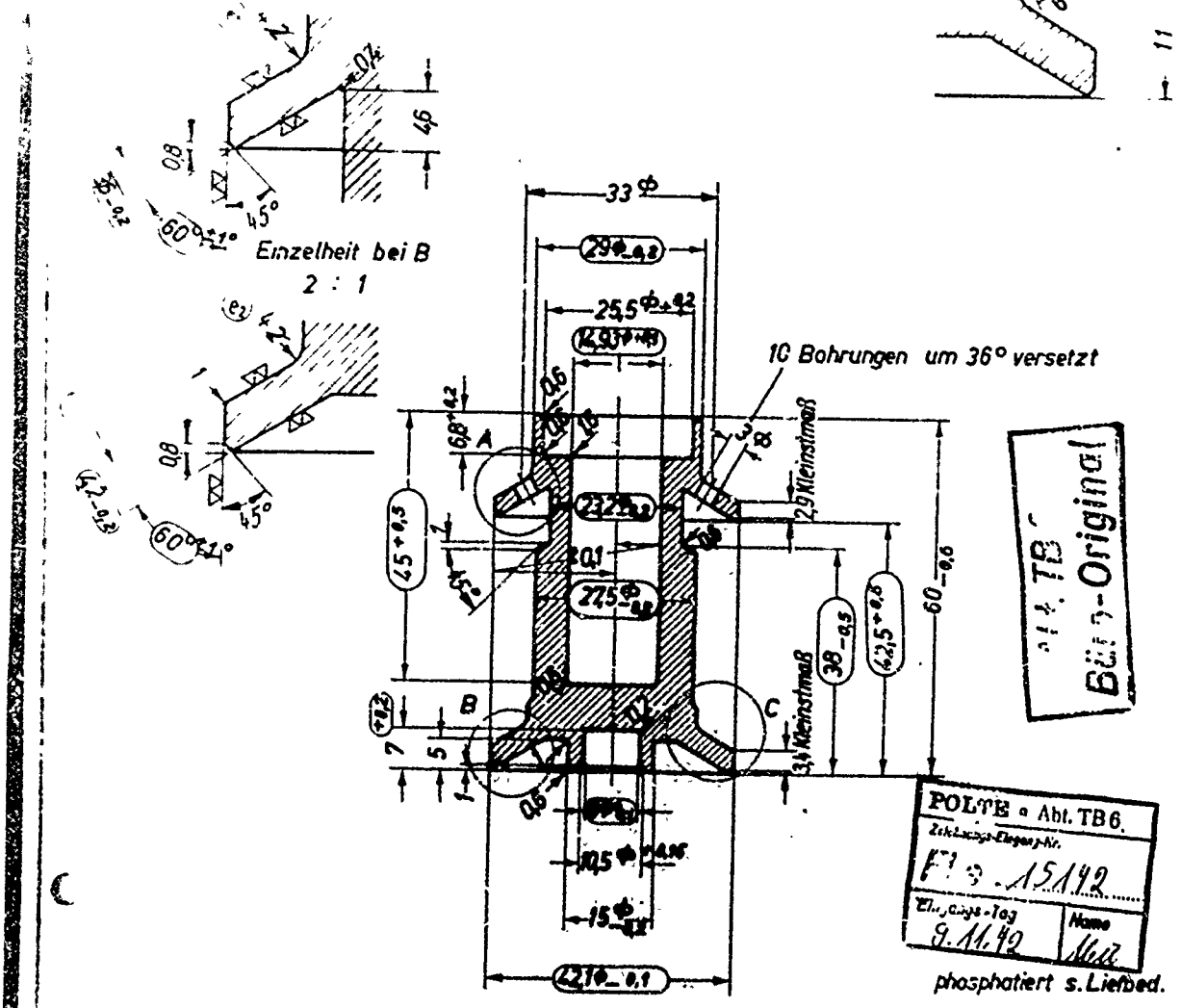
Three types of sub-caliber projectiles were used: the Pfielgeschoss which is a fin stabilized projectile fired from a smooth bored gun, the Triebspiegel geschoss of Sabot projectile which is fired from a normal rifled gun and the flange geschoss. The flange geschoss is fired from a cylindrical, rifled barrel to which a smooth bored, tapered muzzle extension is attached. This type of projectile is called a "Littlejohn" by the British and a "Squeeze Bore" by other services.

The projectiles fired from guns of the type with the tapered muzzle extension resemble the projectiles which are fired from the Gerlich gun wihc is a tapered bore, rifled gun. German personnel have stated that projectiles could be interchanged between Gerlich and squeeze-bore guns as the basic problem is the same. This statement is then modified, however, by stating that the projectile fired from a tapered bore gun must be stronger than that fired from the squeeze bore gun as maximum setback force occurs at the same time that the projectile is being squeezed. A cross section of the armor piercing round for the 4.2/2.8 cm. tapered bore gun is shown as Figure 1.

Development and testing of the squeeze bore projectiles was handled primarily by the private firms in Germany, although all branches of the service were interested in and advised of the developments. The principal firm working on this project was the Rhinemetall-Borsig Co., although the Krupp Co. and Bochumer Verein Co. both built experimental projectiles. The firm of Polte, AG in Magdeburg also built projectiles of this type but had worked only on sizes 5.0 cm. and smaller although they were going to build the 5.5/4.1 projectiles which were contemplated.

Projectiles of this type were designated to show the origin caliber

Figure 1



Staatsgeheimnis!

Geheimhaltungsverpflichtung beachten.

Maße gelten vor dem Phosphatieren

Z.V.F. Nr. [illegible]

Werkstoff: St C 16.61 gegl.	e	2×	Radien geänd	16.10.42	
Rohteil: —	d	—	neue Urzeichnung, Darstllg, Maße geänd	28.4.42	
Fertiggew. — Rohgew. —	Kantenstabe	Kantenstabe kommt vor	Änderung	Tag	Name
glatte Fläche ▽ Schlichtfläche	Maßstab		Entwurf 9.4.42		
Schruppfläche ▽▽ Feinschlichtfläche	1 : 1; 2 : 1		Geprüft 9.4.42		
Maße Maße werden bei Abnahme bestad. geprüft			Normgeprüft 9.5.42		

Zeichnung Nr. 13E 1113–1

Fertigung HTB — POLTE Magdeburg — Hülle

1. Introduction. (Cont'd.)

ard end caliber of the gun. Thus the 10.5/8 cm. squeeze bore projectile is one which is fired from a 10.5 cm. gun to which is attached a conical muzzle extension tapered to an emergent caliber of 8 cm.

The principal advantage of the squeeze bore projectile in comparison to the other sub-caliber projectiles is that it has no discarding parts.

2. Sizes.

The following chart is believed to be a complete list of all projectiles of this type which have been built or planned:

Size	Number of Rounds built of fired.
24/21 cm.	500 rounds fired.
24/18 24/17.5 24/17	Total of 600 rounds fired.
12.8/9.6	Never fired, planned only.
10.5/8.8 10.5/8.3	About 20 rounds fired.
10.5/8.0	Estimate 9,000 rounds fired - this total includes an estimated 50 different designs.
10.5/7.5	100 to 150 rounds fired.
8.8/7.0	Work just commencing - about 200 rounds fired.
8.0/5.5	Not fired. Planned only.
7.5/5.5	In service as 7.5 cm. Pak 41
7.0/5.2	Prototype of 7.5 cm. Pak 41 - 1200 rounds fired.
5.5/4.2 5.5/4.1	Never built. Designed late in 1944 as anti-aircraft weapon.
5.0/3.7	Model for anti-tank gun.

3. Construction.

The principal source of information on construction details of the German "Squeeze bore" projectiles was Dr. Werner Banck. Dr. Banck was in charge of this project for the Rheinmetall-Borsig Co. for the period from late 1939 through until the end of the war. In the organization chart for the company, Dr. Banck was in charge of the army high velocity

3. Construction. (Cont'd.)

projectile sub-section of the weapons construction and ballistic department of Rheinmetall-Borsig.

Additional information has been gained from interrogation of proving ground personnel at the German Army Proving Grounds at Hillersleben and interrogation of Rheinmetall-Borsig and German Navy ordnance personnel.

(a) Two Flanges.

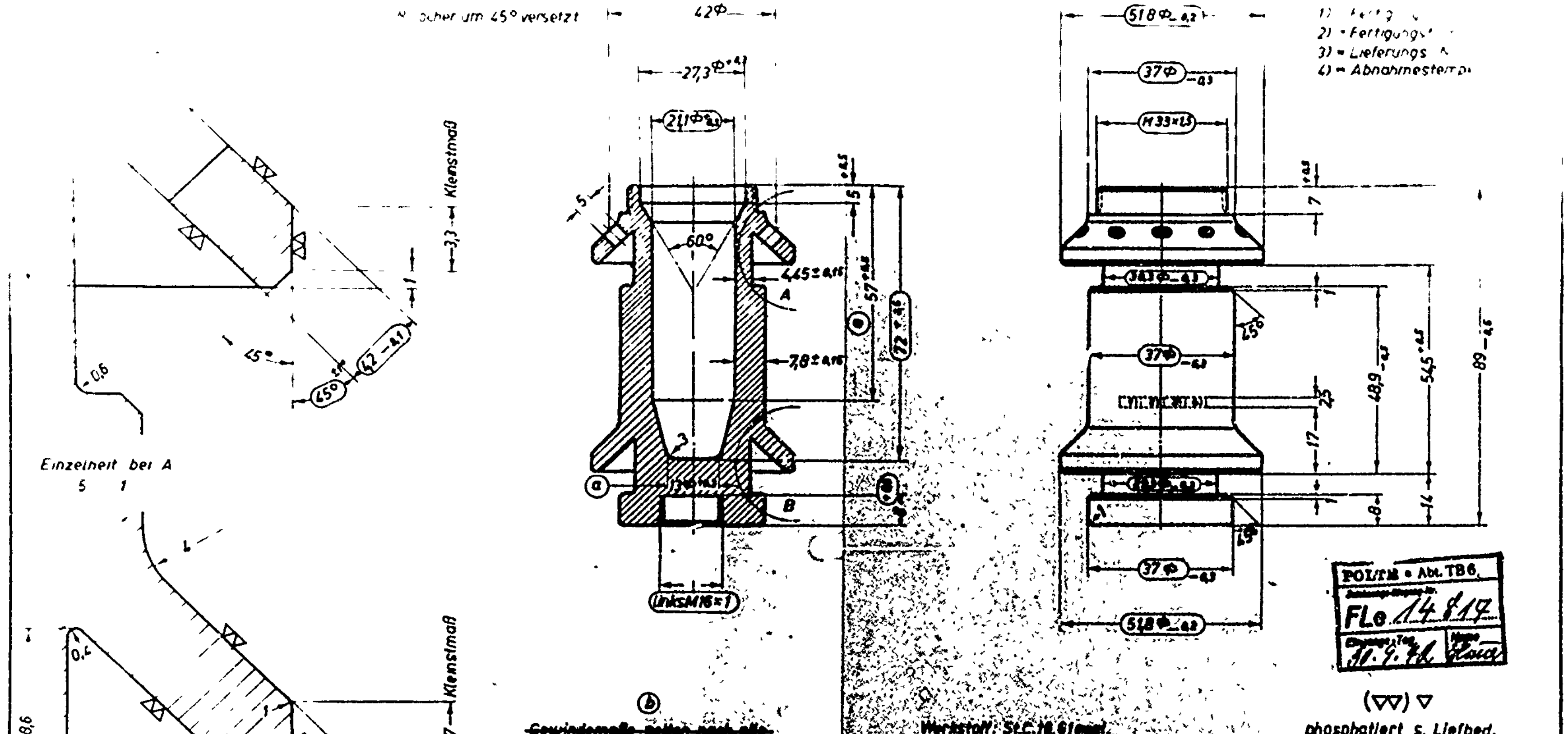
The first type of construction developed employed two solid flanges, forward and rear, as Bourrelet and rotating band respectively. This was modified slightly by drilling holes in the forward flange but this type of construction was abandoned in sizes 8.8 cm. and above since it proved to be unsatisfactory.

This type of construction proved to be unsatisfactory because it was found that the propellant gases leaked past the rear flange. Then when the projectile passed through the conical muzzle extension the gas was compressed and, even in spite of the drilled holes in the forward flange, large gas pressures were built up, (gas pressures up to 6000 atmospheres were recorded). This resulted in destruction or deformation of the projectile body. Also it was found that at the moment when the projectile left the barrel the extra pressure caused the deformed forward flange to tear and fly off. Several methods of providing a possibility of escape for the enclosed gases were tried other than drilling of the flanges. In the end it was recognized that, in principle, an improvement could be achieved only by splitting up the forward guide into individual supports.

Details of construction of the type with flanges forward and aft is shown in Figure 2. This projectile is the ,.0/3.7 cm. round. Cross-section drawing of the 10.5/7.5 cm. armor piercing round is shown in Figure 3. Cross sections of the armor piercing and high explosive rounds for 7.5/5.5 cm. projectiles are shown in Figure 4. Figures 5, 6, and 7 show external views of the 7.5/5.5 cm. projectiles after firing.

(b) Forward Bolts and Rear Flange.

The first type of individual forward supports that was attempted involved the use of three individual bolts in place of the forward flange. They were so placed and arranged that they were pressed into the projectile



POLTE • Abt. TB6.
FLe 14 814
31.9.42

(▽▽) ▽
phosphatiert s. Liefbed.

Werkstoff: St.C.16.61(gegl.)

ⓑ
~~Gewindemaße gelten nach allen übrigen Maße vor dem Phosphatieren. Gewindegrenzmaße vor dem Phosphatieren bei Bolzengewinde kleiner, bei Muttergewinde größer um 0,04 im Flanken-Φ und 0,02 im Außen- und Kern-Φ.~~

~~Gewindeabnahme vor dem Phosphatieren.~~

ⓑ	1. x	Text gestrichen	30.9.42
ⓐ	2. x	Bodenform geändert	28.9.42
—	—	neue Urzeichnung	23.9.42

52 GN-15

13 D 1128-1

POLTE Magdeburg

Abt. T.B9

52GN-14b

Hülle

Ersatz für: PN 1342 f

Ersatz durch:

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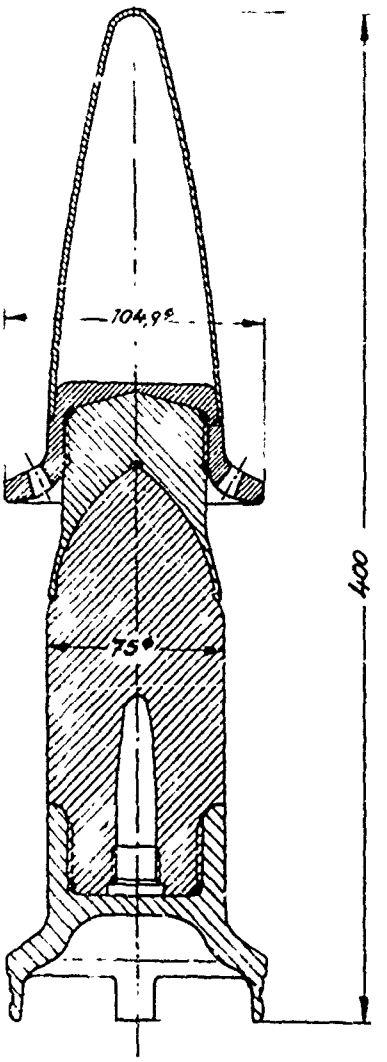
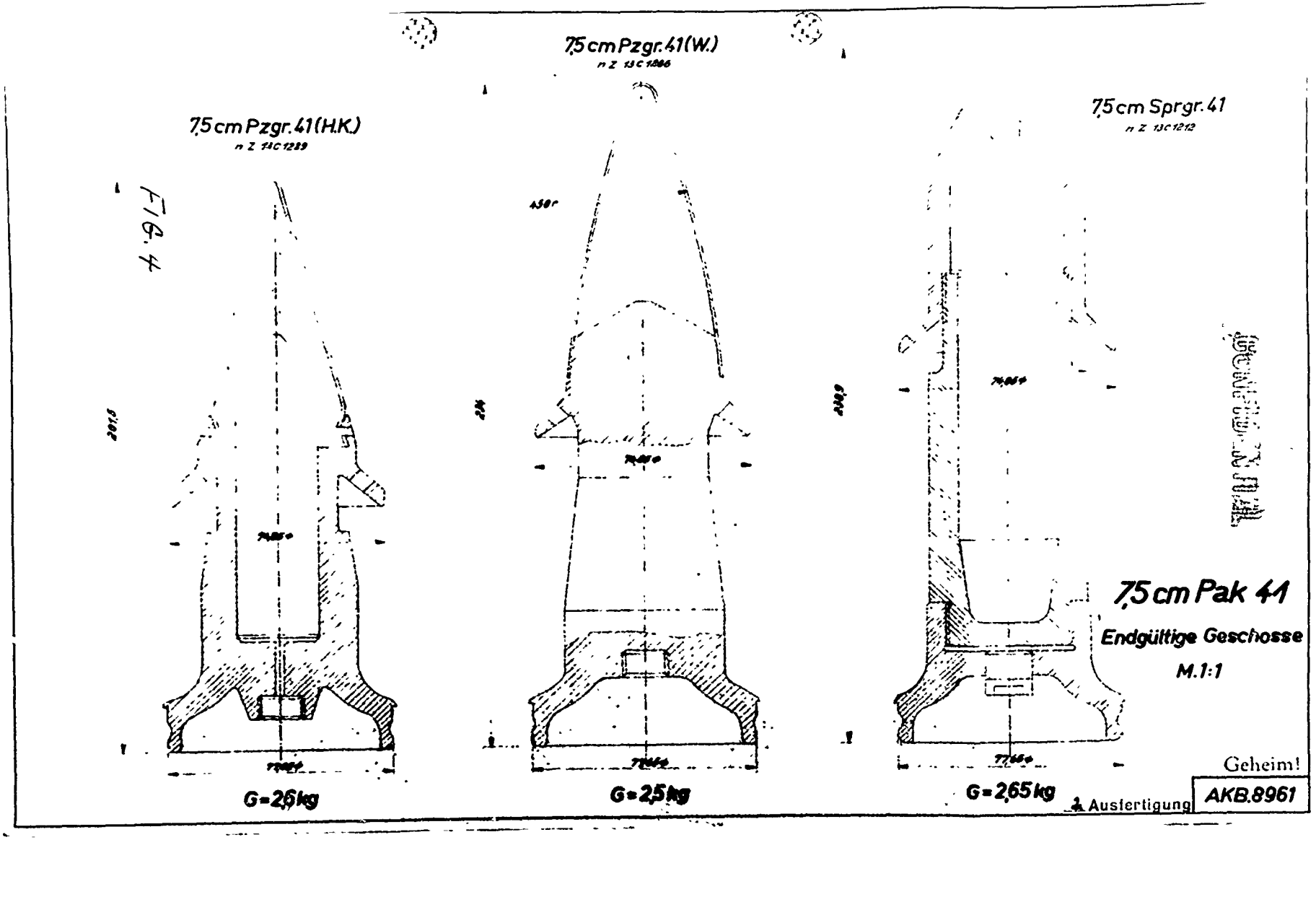


Fig 3

10,5/7,5 cm Pzgr.	4V150


7,5 cm Pzgr. 41 (H.K.)
n Z 13C 1289
7,5 cm Pzgr. 41 (W.)
n Z 13C 1286
7,5 cm Sprgr. 41
n Z 13C 1212
Fig. 4
G=2,6 kg
G=2,5 kg
G=2,65 kg
7,5 cm Pak 41
Endgültige Geschosse
M. 1:1
Geheim!
1 Ausfertigung
AKB.8961

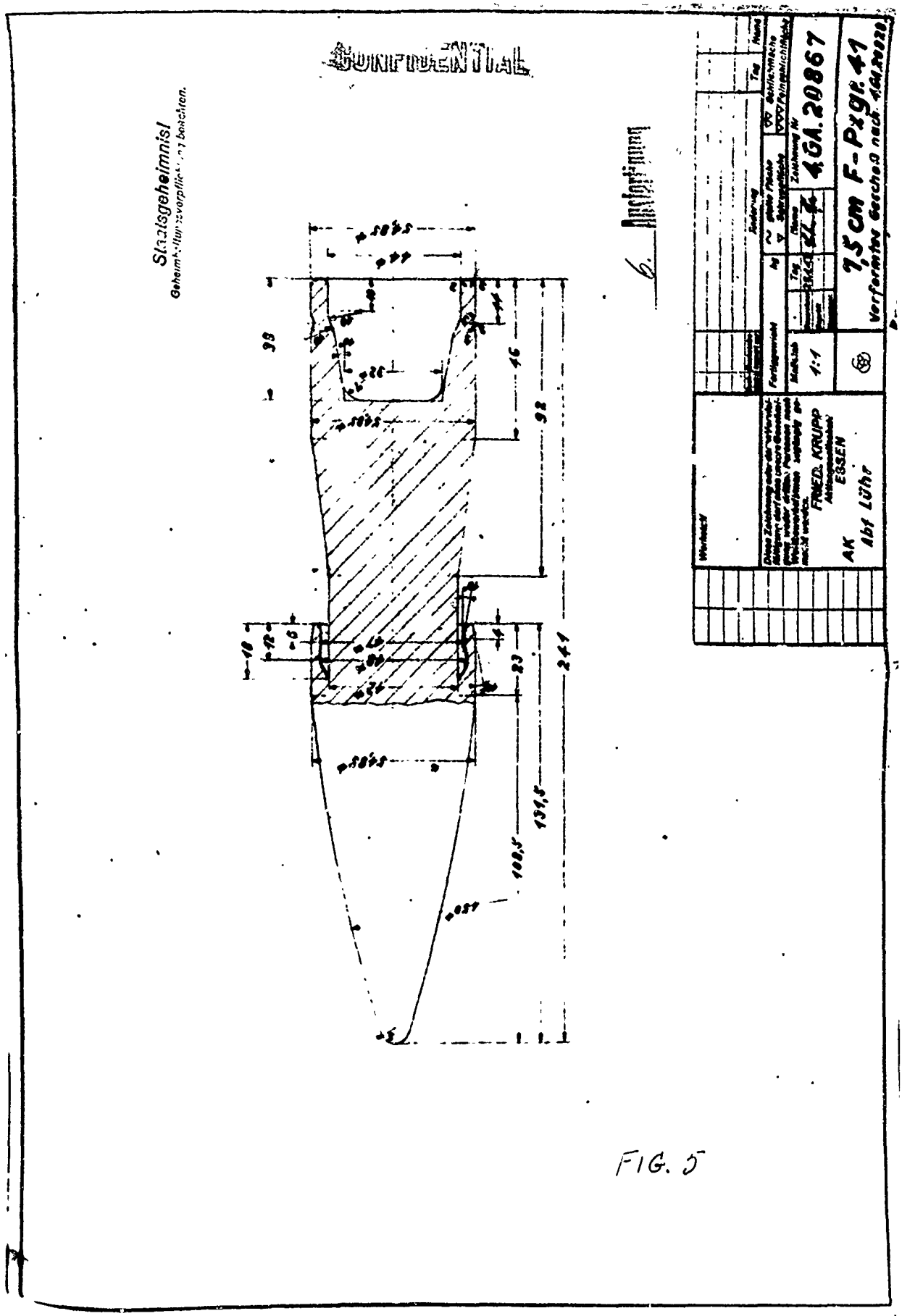

SUNDERN TAL
Staatsgeheimnis!
6. Anfertigung
7,5 cm F-Pzg. 41
4GA.20867
1:1
FRIED. KRUPP
ESSEN
AK
Abt Löhr

FIG. 5

3. Construction. (b)(Cont'd.)

body when the projectile passed through the muzzle squeeze. On the base of the bolts' ribs were arranged so that once the bolts were pressed into the projectile body, the ribs caught and the bolts could not be thrown out be centrifugal force.

Since these bolts actually extend into the explosive cavity of the projectile, production of the projectile was considerably complicated. Projectiles were actually built in two parts with the explosive cavity divided. This made uncertain the complete detonation of the high explosive filler and impaired the effeciency of armor piercing projectiles since the cap and nose were weakened.

In an attempt to be able to use normal projectiles an attempt was made to enclose the bolts in individual casings which were screwed or attached to drilled holes in the projectile bodies. This eliminated none of the disadvantages of this type of construction and considerably weakened the projectiles due to the drilled holes.

Both of these constructions were made up and fired, in small quantities, in calibers 24/17 cm. and 10.5/5 cm. sizes. This construction was abandoned, however, because of the disadvantages. No drawings are available for this type of construction.

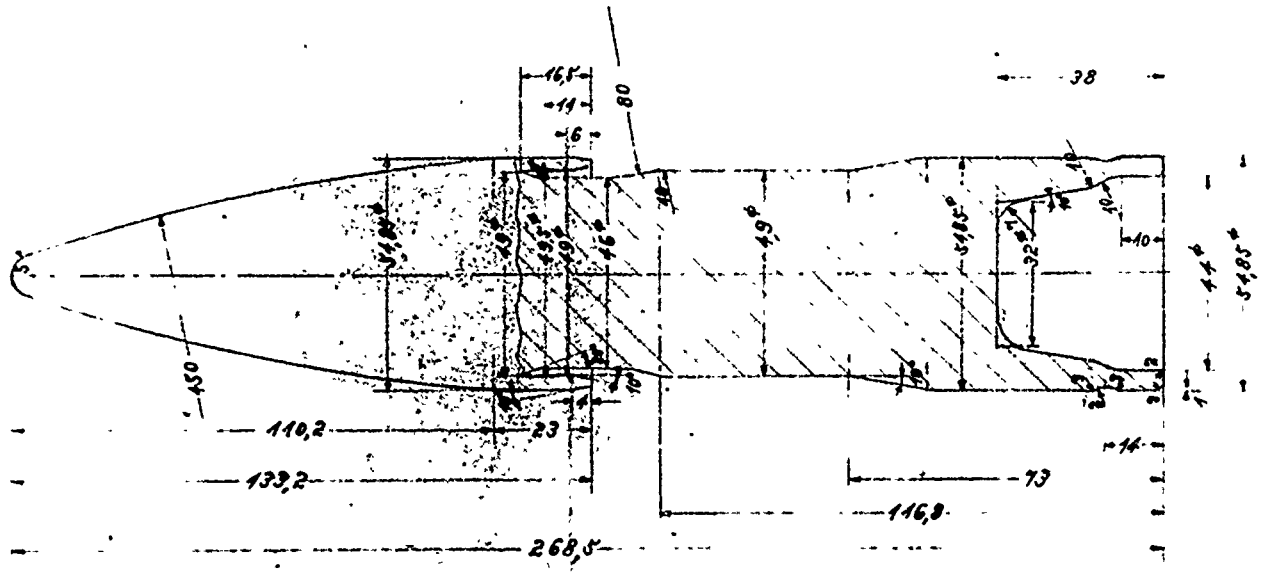
To attempt to eliminate the disadvantages involved in the use of long bolts various attempts were made with telescoping bolts of various types. Some of these constructions were fired but this construction was also abandoned early in 1942 in favor of the hollow support studs which have been recognized as the best type of forward support.

(c) Hollow Support Studs.

The final type of projectile which was built for the "squeeze bore" guns was the type with the so-called hollow support studs. Construction of projectiles of this type was begun in May 1942. Figures 8 and 9 show 24/21 cm. projectiles with hollow support studs and figures 10 and 11 show 8.8/7.0 cm. projectiles with hollow support studs.

In this type of construction the stud, of soft steel, is pressed into a drilled hole in the projectile body. A sharp edge on the lower portion of stud engages a recess in the drilled hole and thus the stud is secured. Then when the projectile is fixed and passes through the muzzle squeeze the studs are forced down into the drilled holes in the projectile body.

Staatsgeheimnis!

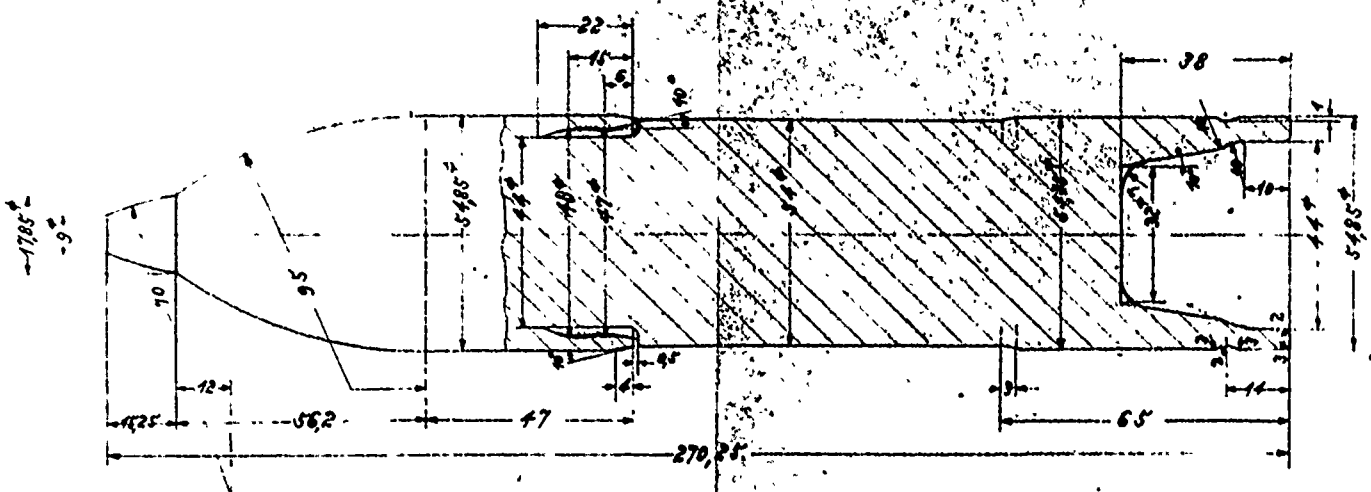


7.5/5.5

6. Ausfertigung

Werkstoff		Änderung	Tag / Name
Diese Zeichnung oder deren Vervielfältigung darf ohne unsere Genehmigung weder dritten Personen noch Wettbewerbsfirmen zugängig gemacht werden. FRIED. KRUPP Aktiengesellschaft ESSEN	Fertiggewicht kg	~ glatte Fläche ▽ Schruppfläche	▽▽ Schlichtfläche ▽▽▽ Feinstbearbeitet
AK Abt. Lühr	Maßstab 1:1	Tag 22.1.45	Name Lühr	Zeichnung Nr 4.GA.20865
			7,5 cm Pzgr. 41 (St. K) Verlaimtes Geschoß nach [illegible]

Geheimhaltungsverpflichtung beachten

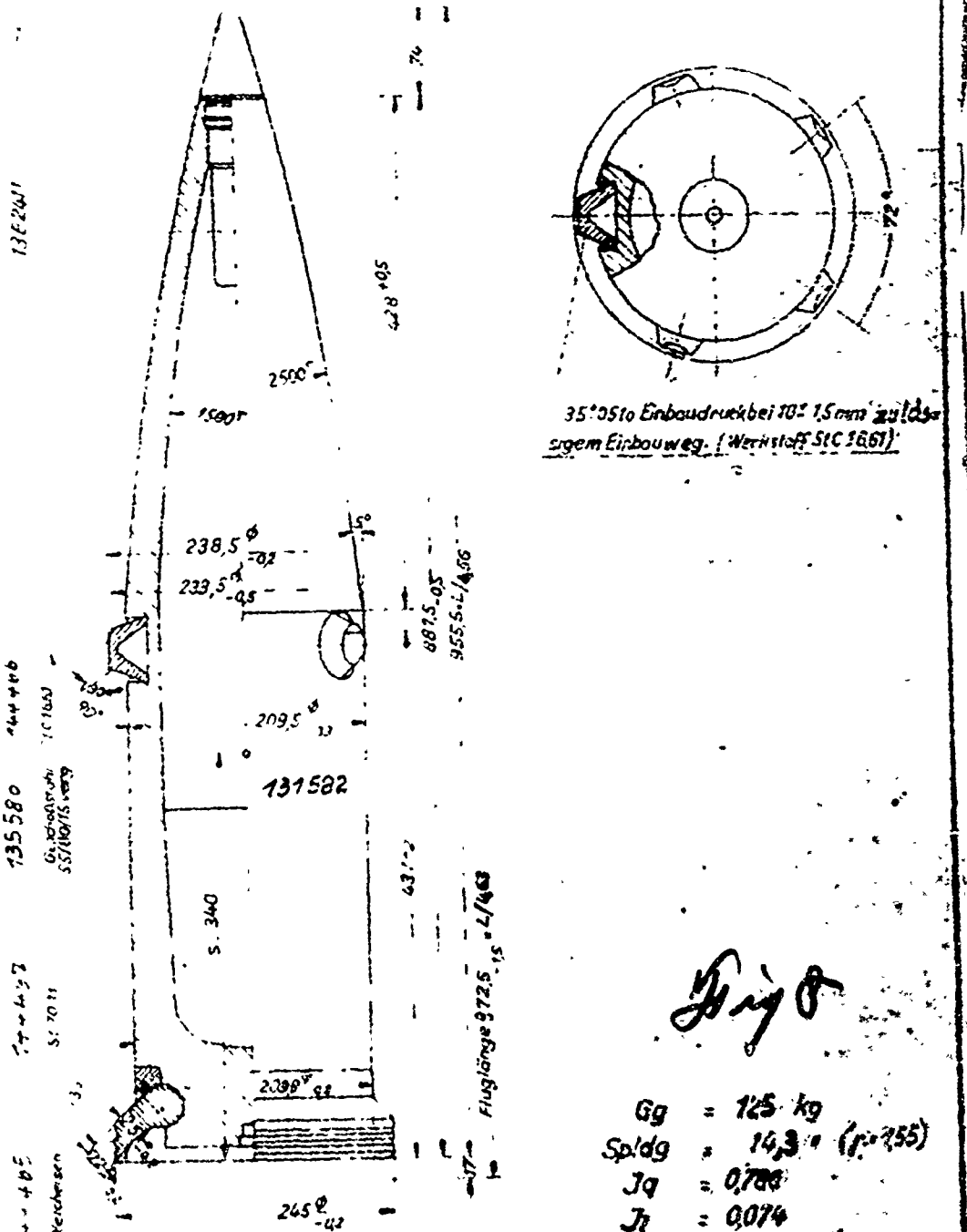


6. Ausfertigung

Werkstoff			Änderung	Tag	Name
Diese Zeichnung oder deren Vervielfältigung darf ohne unsere Genehmigung weder an Nicht-Personen noch Wettbewerbsfirmen zugänglich gemacht werden.	Fertiggewicht kg	~ glatte Fläche ▽ Schruppfläche	▽▽ Schlichtfläche ▽▽▽ Feinschlichtfläche		
FRIED. KRUPP Aktiengesellschaft ESSEN	Maßstab 1:1	Tag 22.2.40	Name Schäfer	Zeichnung Nr 4.GA.20866	
AK Abt. Lühr		7,5 cm Granate 41 Verformtes Geschoß nach 13C 1212			

24 cm Sprenggr 41

nach Stückliste St 131582



35°0510 Einbaudruckbei 10± 1,5mm zugeordnetem Einbauweg. (Werkstoff StC 1661)

Gg = 125 kg

Spldg = 14,3 (i = 155)

Jq = 0,786

Jt = 0,074

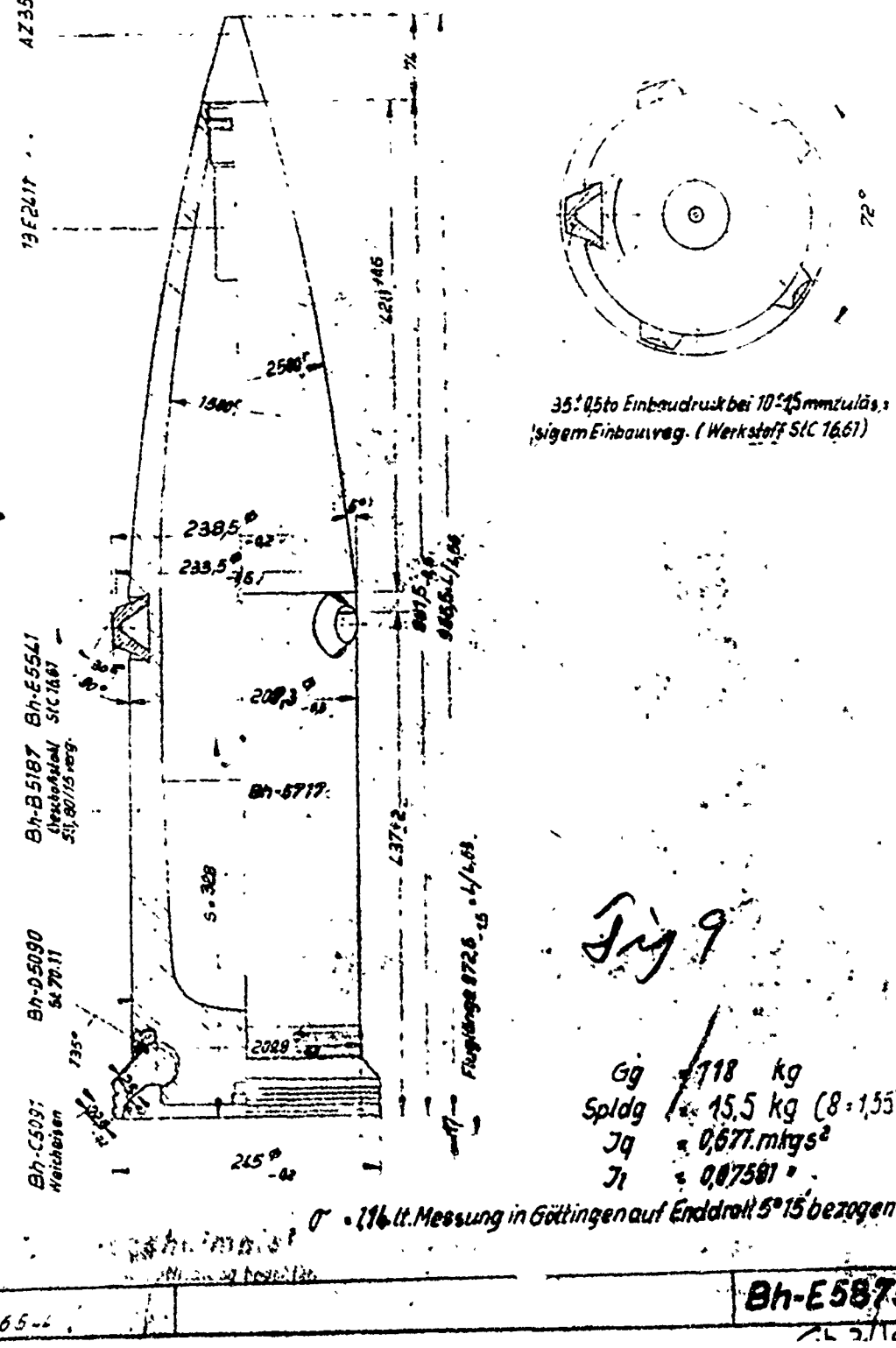
σ = 1,3 lt. Messung in Göttingen auf Enddrall 15°15' bezogen

Bemerkungen	ZR-St 27297

...e'al Barag
... Sommerda
WKB

24/21cm Sprenggr 41

nach Stückliste St 131598



35 to Einbaudruck bei 10 mm zulässigem Einbauweg. (Werkstoff StC 16.61)

Fig 9

Gg = 118 kg
Spldg = 15,5 kg (8 : 1,55)
Jq = 0,677 mkgs²
Jt = 0,07581 "

Ø = 116 lt. Messung in Göttingen auf Enddrall 5°15 bezogen

Bh-E5873

26 5-4

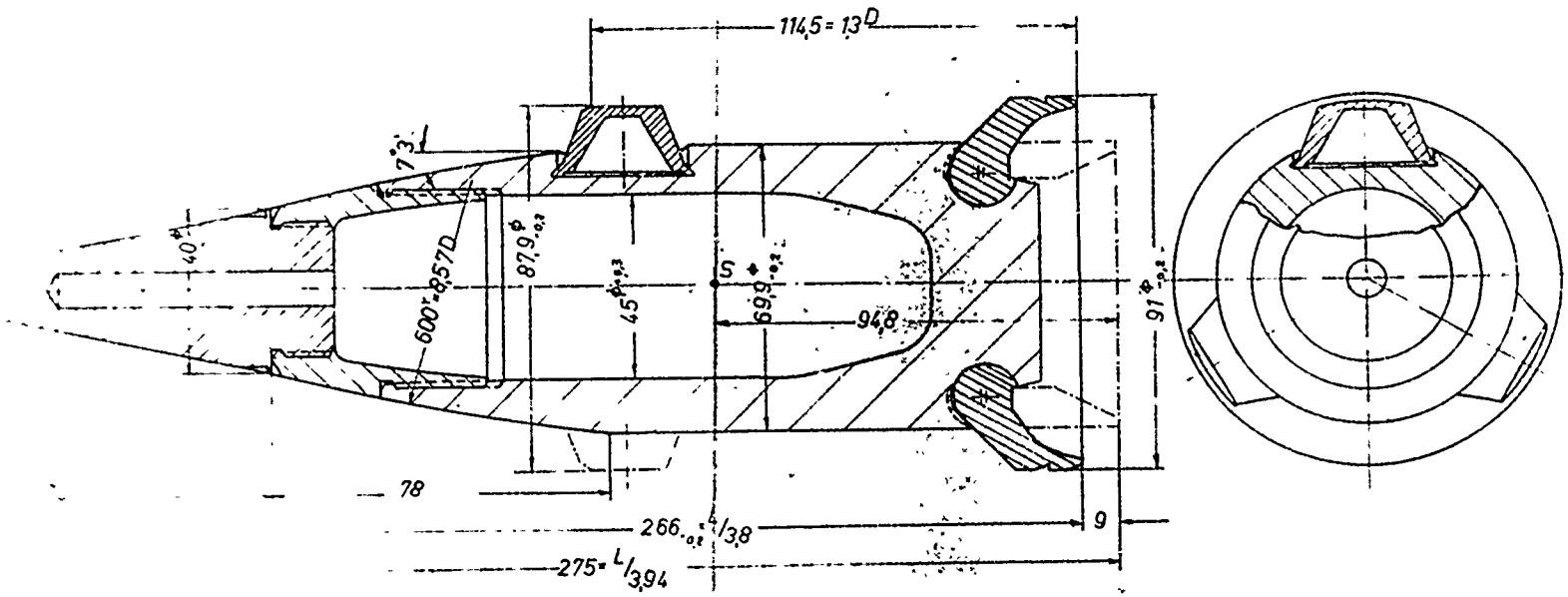
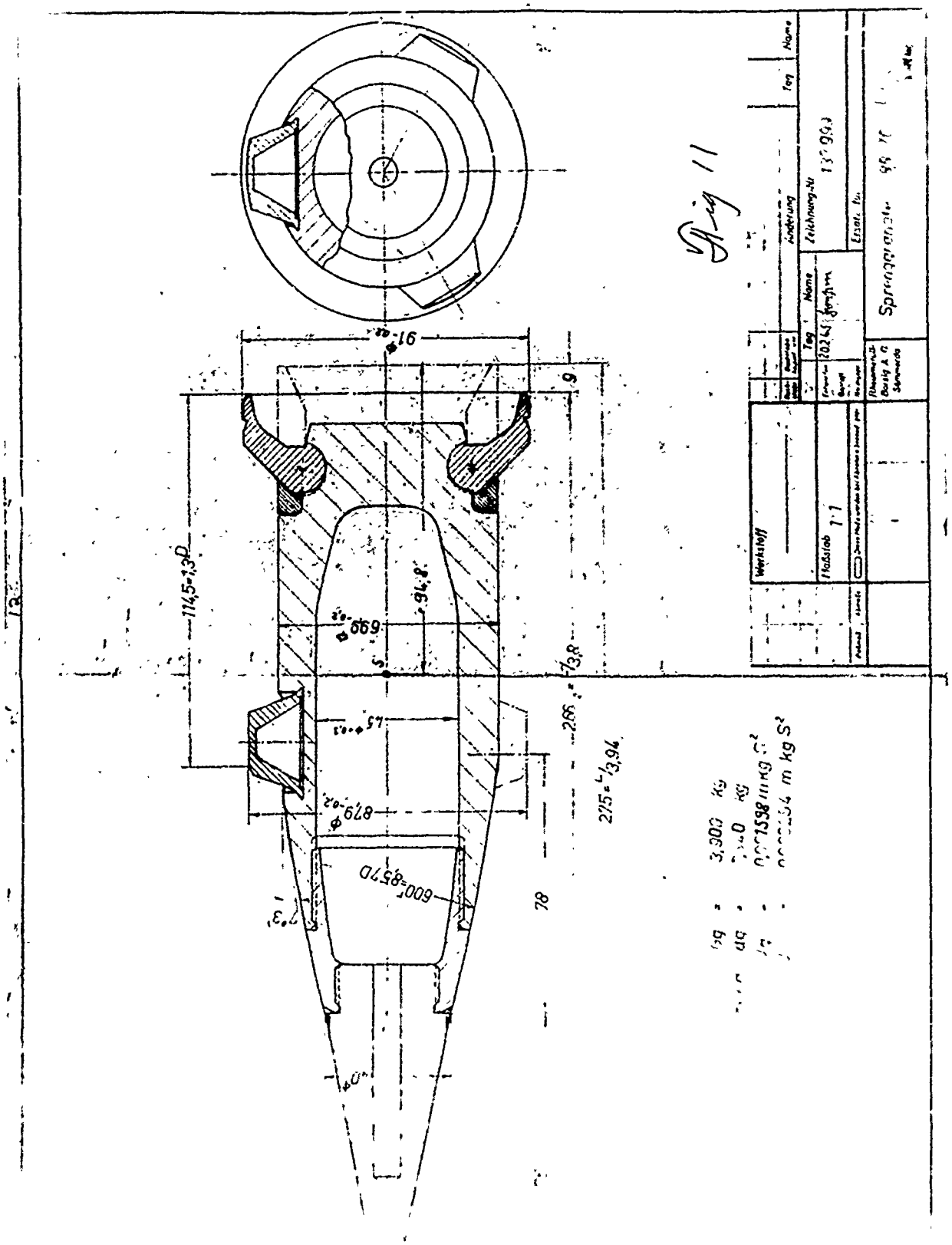


Fig 10

Gg = 3,900 kg
Spreng-Ldg = 0,340 kg
J_p = 0,001598 m kg S²
J_1 = 0,000254 m kg S²

Werkstoff			Änderung	Tag	Name
Maßstab 1:1	Gezeichnet	Tag 16.2.45	Name	Zeichnung-Nr 160041	
	Geprüft			Ersatz für	
Rohmaß Abzug	Dieses Maß wurden bei Abnahme benötigt, gepr	Norm gepr	Rheinmetall-Borsig A.-G. Sömmerda	Sprenggranate 8,8 / 7,0 L/3,8	



3. Construction. (c)(Cont'd.)

In smaller sizes such as the 8.8/7.0 cm. round only three studs were used, thereas, in larger sizes such as the 24/21 cm. projectiles five studs were used. In all cases the studs were wider than the grooves of the rifling with the Germans using a figure of 1/5 caliber for the width of the stud.

The advantages claimed for this type (hollow support stud), as listed by Dr. Banck, are as follows:

(1) Considerably less wear of the conical muzzle squeeze.
(2) Use of normal projectile bodies because:

No gas is compressed, consequently there is no pressure on the projectile body.

Because of the small depth of the attached studs the projectile body does not need to be thicker than normal.

(3) If the muzzle extension is worn and studs not completely collapsed. The increase in air resistance caused by the protuberance of the studs is considerably less than that caused by a forward flange not being completely collapsed.
(4) Studs weigh less and use less material than the flange.
(5) Less irregular wear in the cone.
(6) Less sensitive to steep cones in the muzzle piece.
(7) No space is taken from the explosive chamber.
(8) In armor piercing projectiles the projectile nose is not weakened.
(9) No special machines are necessary to drill the holes for the studs. An ordinary lathe can be used.

All studs for these projectiles were made of soft steel. The most satisfactory method of manufacture was found to be pressing them from sheets and then further pressing of the studs into drilled holes in the projectile body. In this pressing, the material is strained beyond the elastic limit and, for equal thicknesses, it was the German claim that the studs could be constructed lighter and better since the strength is increased.

(d) Rear Fitting.

In all cases the rear fitting was of soft iron. This was the only

3. Construction. (d)(Cont'd.)

material made available for experimentation due to the German copper shortage. No experimental work was done with copper or copper alloys. German personnel who have been interrogated have stated that use of copper might be advantageous and feel that it might allow a larger reduction in caliber. All of them pointed out that the material of the forward studs and rear flange should be the same or trouble would be experienced with heavy erosion in the muzzle extension.

The first method of attaching the rear fitting was to machine a groove around the base of the projectile body, then heat the projectile and press the cold flange in. Trouble was experienced with this system due to the projectile base cracking after cooling and it was abandoned.

The most satisfactory method of attaching the rear flange was found to be that of heating the rear flange to a temperature of 1120°C. and forming it while pressing the flange into the projectile body with a hydraulic press. Pressure used on the 24/21 cm. projectile was 400 tons and on the 10.5/8 cm. projectile 150 tons. For projectiles ranging up to 8.8/7.0 cm. in size it was expected to press the flanges on without heating them.

Rheinmetall-Borsig shop personnel stated that from the manufacturing standpoint it was found that this system of hot pressing the rear flange on was cheaper than the assembly of ordinary rotating bands.

No manufacturing tolerances were available for either the studs or the rear fitting as no quantity production of these projectiles had been made.

In the conversion of existing projectiles difficulty was encountered only when boat tailed projectiles were worked on. Rotating bands, of course, had to be removed.

(e) Explosive Loading.

High explosive loaded projectiles were built and fired in all sizes. Wall thickness was the same as ordinary HE projectiles and in some cases, such as the 24/21 cm. projectile, existing projectiles were built up by the addition of studs and a rear flange. No special HE filler was used. Normal loading (same as ordinary HE projectiles) was used.

3. Construction. (c)(Cont'd.)

(f) Fuzing.

In the 24/21 cm. size the fuzing was a sensitive impact fuze. The 10.5/8 cm. was fuzed with the standard 30 second time fuze. Other projectiles were fuzed with impact fuzes and an impact fuze with self-destroying device was reportedly under test. The effect of the muzzle squeeze on the rotation of the projectile was stated to be very little if the squeeze dropped on a ratio of 1 mm. width per 30 mm. in length. However, if this ratio was changed to 1:50 the revolutions per minute of the projectile was slowed down. Other changes in construction necessary before converting standard fuzes into servicd in high velocity projectiles were not ascertained.

4. Exterior Ballistics.

(a) Muzzle Velocity.

The maximum muzzle velocity attained with this type of projectile was stated to be 1400 m/s. 1150 to 1200 m/s was believed, however, to be the most feasible service velocity.

(b) Dispersion.

Dispersion with this type of projectile was expected to be as good as that obtained with normal projectiles. Range dispersion of 1% was expected and deflection of around 1.5 mil. Actual service tests showed frequent wild shots, however.

(c) Change in Form Factor.

Lift of the gun was stated by Dr. Banck as being determined by actual wear on the muzzle extension. For example, the 10.5/8 cm. muzzle extension was changed when 2 mm. of wear could be measured. As the muzzle extension wears the studs and rear flange are not completely forced down so a change in form factor results. This change, even if muzzle velocity remained constant, means a decrease in range and an increase in flight time.

German personnel stated that the hollow space formed at the base of the projectile due to the folding of the flanges had an effect of increasing the stability.

3. Construction. (Cont'd.)

(d) Range Tables.

No range tables had been made for any of these guns since they had not been introduced to service. It was the assumption that muzzle velocity and range would be increased approximately one-third.

5. Conclusions.

The following conclusions have been formed on the German high velocity projectiles of this type designed to be fired from guns with tapered smooth bored muzzle extensions:

(a) Only the 7.5 cm. Pak (anti-tank) gun had been introduced to service. The 10.5/8 cm. gun and projectiles were believed to be ready for service but had never gone into production.

(b) Favored construction is the type with collapsing (hollow support) studs forward and soft iron flange pressed on the rear as rotating band.

(c) No material other than soft iron had been made available for manufacture of studs and flanges. German personnel feel that copper or a copper alloy might be more satisfactory.

(d) High explosive loaded projectiles were designed for all sizes and fired in all sizes which reached test status. Standard types of HE fillers were used and wall thickness of the projectiles was the same as projectiles fired from normal guns.

6. Shipments.

(a) By serial letter 947 from NavTecMisEu to CNO (Attn: OP-16-PT) dated 10 September 1945 working drawings of squeeze bore projectiles were forwarded.

(b) Technical report #384-45 from U.S. Naval Technical Mission in Europe on the subject of German Development of Sub-Caliber High Velocity AA Projectiles contains information on the flanged projectiles used for anti-aircraft.

(c) Technical Report #458-45 from U.S. Naval Technical Mission in Europe on the subject of German Development of High Muzzle Velocity Guns contains information on the squeeze bore guns for the flange projectiles.

Prepared by:
Lieut. R. T. Wright, USNR